inštitút finančnej politiky

Policy brief 2021/3 Ministerstvo financií SR / www.finance.gov.sk/ifp

February 19th, 2021

Manufacturing in times of COVID-19[1]

The impact of the first wave of the pandemic on industrial activity in Slovakia

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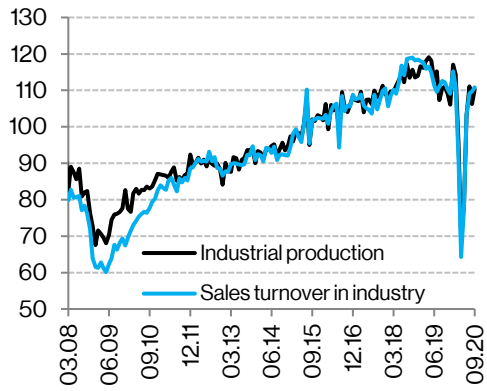
Slovak manufacturing recorded a historic decline during the first wave of the coronavirus pandemic. The main reason was the country's reliance on car production, but quarantine measures also contributed to the decline. The favourable development of the pandemic during the summer months improved industrial activity and led to a rapid recovery in car manufacturing. As a result, production rebounded at a faster rate than during the global financial crisis.

The COVID crisis led to a historic decline in industrial activity

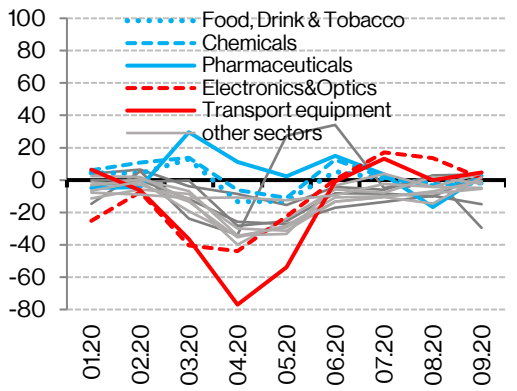
In the first months of the pandemic, Slovakia recorded the steepest decline in manufacturing activity among all EU countries. Production and turnover fell in most manufacturing sectors, caused by a fall in foreign demand, supply chain disruptions, as well as quarantine measures. Industrial activity bottomed out in April, 42 per cent lower than in the previous year. This marked the steepest decline in production ever recorded in the history of Slovakia (Figure 1). As the economy gradually re-opened in May, manufacturing started to recover, aided by the similar favourable developments in the economies of our trading partners. Owing to robust growth in May, manufacturing recovered over three quarters of its pandemic-induced losses in production.

Figure 1: Industrial production and turnover (SA, 100 = 2015)



Source: ŠÚ SR, IFP

Figure 2: Year-on-year growth in manufacturing sectors (in %)



Source: ŠÚ SR, IFP

Production fell in most sectors...

During the first wave of the pandemic, pharmaceutical products, chemicals and food production proved to be the most resilient sectors of manufacturing in terms of sales turnover (Figure 2).[2] The demand for foodstuffs was high during the first months of the pandemic when many households tried to stockpile food for later use, but also due to spending more time at home.[3] The measures taken to limit the spread of infections and

[1] The author thanks Daniel Dujava and Branislav Žúdel (IFP) for their valuable insights, and Ján Beka (NBS) and Miroslav Kľúčik (RRZ) for reviewing the policy brief.

[2] Y-o-Y growth of industrial activity in May and June were influenced by the production of coke and oil. Upon investigating a longer time-horizon, it becomes clear that these sectors grew mainly thanks to a lower base in 2019 when oil producers stopped production for two months (base effect).

[3] Google mobility data indicate that the time spent by households at home increased by 20 per cent relative to February. Source: https://www.google.com/covid19/mobility/, accessed on 30 October 2020.

the decline in foreign demand, however, had a considerable impact on other manufacturing sectors, mainly the production of electronic and optical devices, and the automobile industry. Sales turnover in car production fell by 77.1 per cent in April.

Figure 3: Industrial production (SA, 100 = pre-crisis peak)

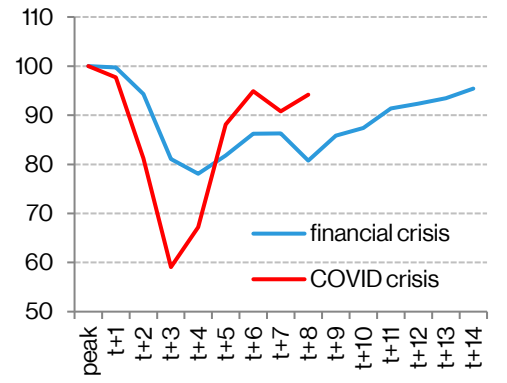
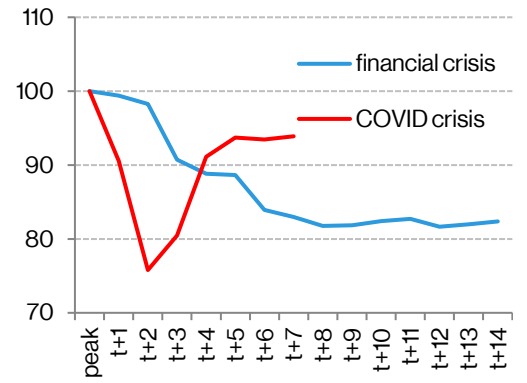


Figure 4: Hours worked in industry (SA, 100 = pre-crisis peak)



Note: September 2008 is the pre-crisis peak for the financial crisis, while January 2020 (February 2020) is the pre-crisis peak for the COVID crisis (February 2020 for hours worked). Source: ŠÚ SR, IFP

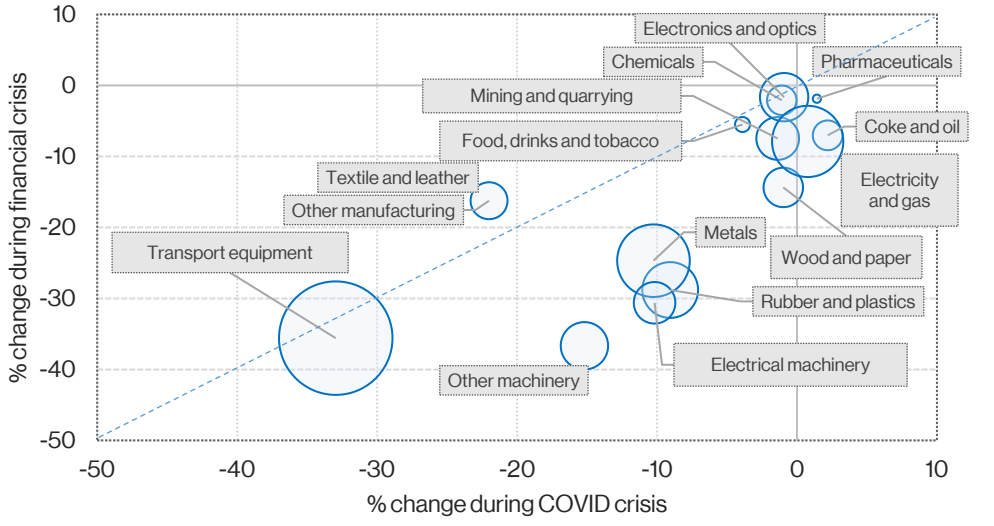
...but the recovery was also swift.

The fall in industrial production caused by the pandemic surpassed the impact of the global financial crisis. On the other hand, current data on production and hours worked in manufacturing indicate a faster recovery. Compared to their peaks from before the crisis, both production and hours worked are relatively higher than during the global financial crisis (Figures 3 and 4).

Most sectors recorded smaller declines than during the global financial crisis.

As the steep declines in activity were relatively short-lived during the first wave of the pandemic, most manufacturing sectors suffered to a lesser extent than during the financial crisis of 2008/2009 (Figure 5). The only sectors which were relatively worse off during the current crisis were textile production and other production which includes the production of furniture, jewellery, musical instruments, sports equipment, repairs etc. The decline in these sectors during the COVID pandemic could be partly related to the fact that consumers had no access to these products for at least a month.

Figure 5: Changes in industrial production during major crises, by sectors (in %)

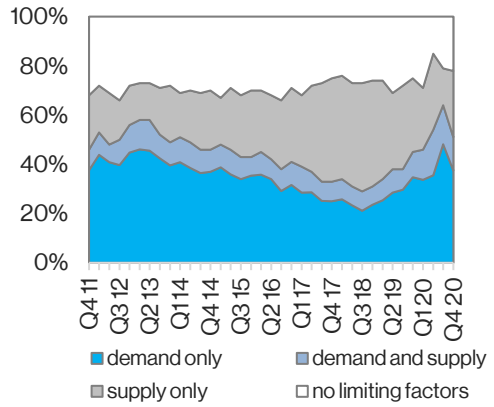


Note: the growth rates measure the changes in industrial production for each sector recorded at five months around the trough of the production index, relative to five months around the peak of the production index. The size of the bubbles indicates the share of each sector on total industrial production. Sources: Eurostat, ŠÚ SR, IFP

The main limiting factor in manufacturing was insufficient demand.

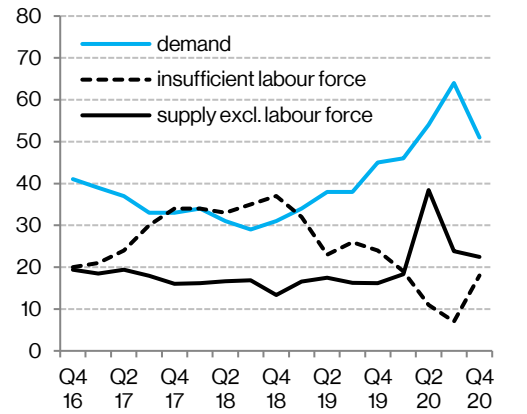
The main limiting factor in manufacturing during the first year of the pandemic was insufficient demand, though supply-side problems also played their part (Figure 6). According to a conjunctural survey of Slovak manufacturers, the share of respondents who claimed that insufficient demand was limiting their production, rose to 54 per cent (Figure 7) in the second quarter of 2020. Around 40 per cent of respondents complained about supply-side factors, while a significant number of respondents listed 'other limiting factors' which were related to quarantine measures.[4] In contrast, the share of respondents listing insufficient labour force as a limiting factor, decreased. Demand-related problems continued to limit production in the third quarter before easing in the Autumn. In the fourth quarter of the year, supply-side limitations began to increase again, caused mainly by insufficient labour force.

Figure 6: Limiting factors in manufacturing (share of respondents in %)



Sources ŠÚ SR, IFP, own calculations

Figure 7: Limiting factors in manufacturing (share of respondents in %)



Sources: ŠÚ SR, IFP, own calculations.

The fall in production was caused mainly by the characteristics of the Slovak economy...

The fact that industrial production in Slovakia fell more significantly than in other countries can be mainly attributed to the specific characteristics of the Slovak economy. Car production contributed to the decline in production not only through its above-average share in the country's manufacturing industry (accounts for approximately one third of the decline), but also through a slowdown in other manufacturing sectors which are linked to the automobile industry (approximately one fourth of the decline). Another fourth of the decline can be attributed to the quarantine measures. The Slovak economy is more open than other EU countries, but this only explains a small portion of the fall in production (approx. 1.5 per cent). When combined, these factors explain around 90 per cent of the fall in manufacturing, the rest can be attributed to the external environment, the fall in global demand, supply chain disruptions, but also to endogenous changes in the behaviour of households and firms in the domestic economy (see Box 1 for a more thorough description of methodology used).

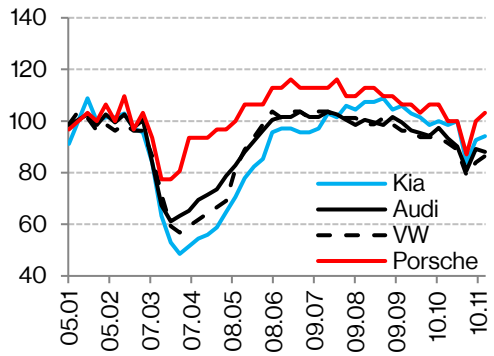
...above all, the large share of the car industry on total manufacturing...

Slovakia's reliance on the automobile industry contributed greatly to the fall in production. In times of crisis, car production tends to decline as consumers limit their spending on durable goods, as can be seen by examining internet searches of major car brands on Google (Figure 8). Apart from the fall in demand for cars at the beginning of the pandemic, production was limited by disruptions to supply chains, which are linked to factories in China and Italy. The unfavourable development in car production spread to other industrial sectors as well, mainly the production of textiles and leather, machines, metal products, and products made of rubber and plastic. We estimated that the

[4] Conjunctural Survey, Number 4, April 2020, Statistical Office of the Slovak Republic.

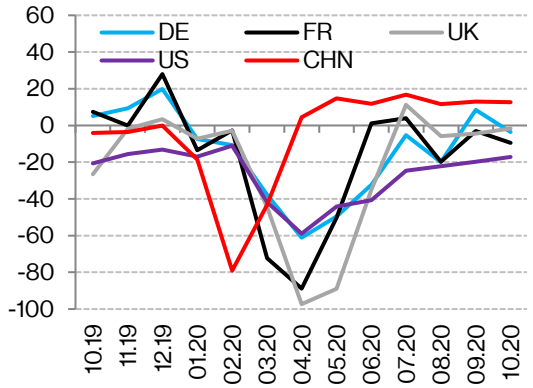
interconnectedness of industries on car production contributed to the fall in manufacturing by 7.8 percentage points which accounts for around a fourth of the total decline in manufacturing. Hence, a higher share of car production on overall manufacturing was correlated with a steeper decline in economic activity (Figure 10).

Figure 8: Internet searches on Google (3MMA, 100 = August 2019)



Source: Eurostat, ŠÚ SR, IFP

Figure 9: Car registrations in partner economies (year-on-year growth in %)

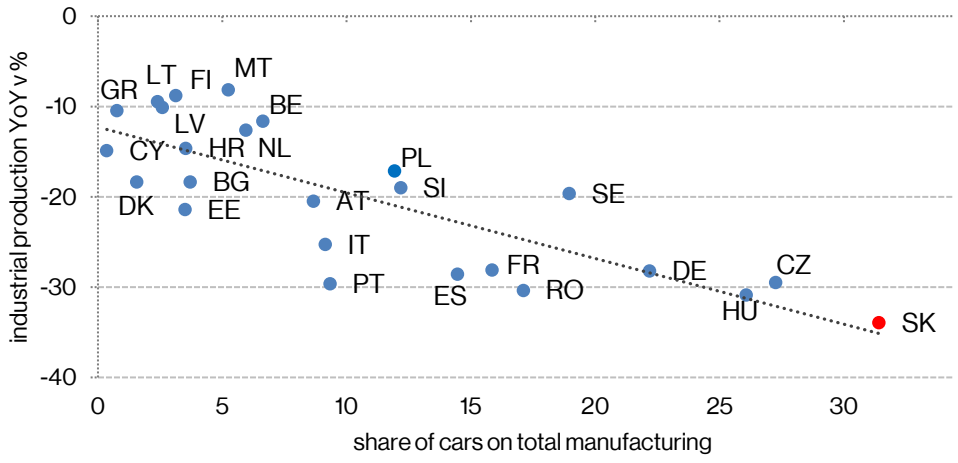


Source: acea.be, Bloomberg, FRED, IFP

...though the demand for cars had recovered by the summer.

The internet searches of car brands recovered swiftly by June and car registrations of our main trading partners also erased most of the losses that were caused by the first wave of the pandemic (Figure 9). Among European countries, France recorded the fastest recovery of car registrations which had already grown in June, mainly owing to generous state subsidies on new vehicle purchases.

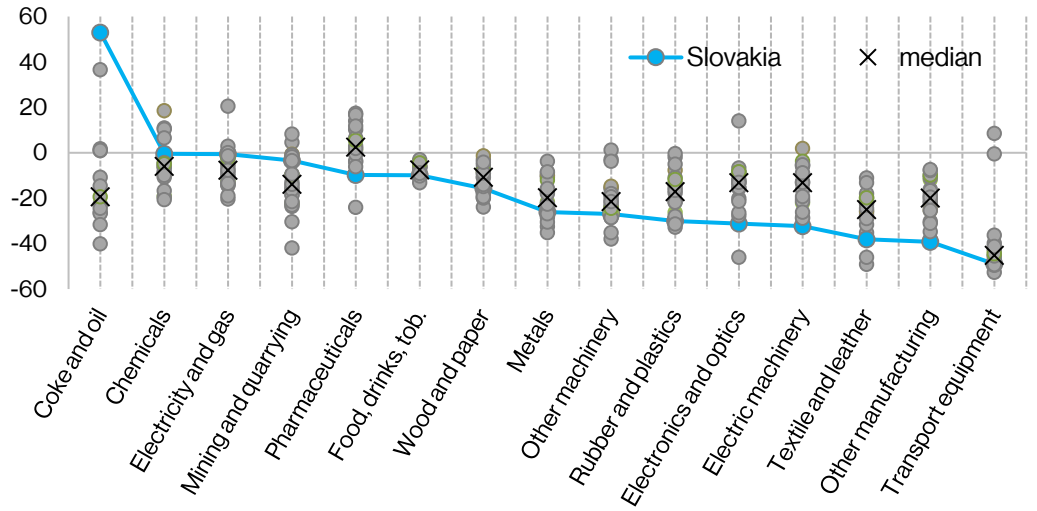
Figure 10: In EU states where cars dominate the manufacturing sector, production fell in May 2020 to a greater extent



Sources: Eurostat, ŠÚ SR, IFP

Other manufacturing sectors recorded declines too, mainly those relatively more exposed to supply-chain disruptions due to their relative openness (Figure 11). **In the second quarter of 2020, 11 out of 15 manufacturing sectors were producing below the EU median**. In year-on-year terms, only the production of coke and oil recorded an increase, though as a result of a strong base effect. The opennes of Slovakia's manufacturing sectors contributed to the fall in overall industrial production by 1.5 percentage points which accounts for around 5 per cent of the fall in the Spring months.

Figure 11: Year-on-year growth of manufacturing sectors in Q2 2020 in EU states (in %)

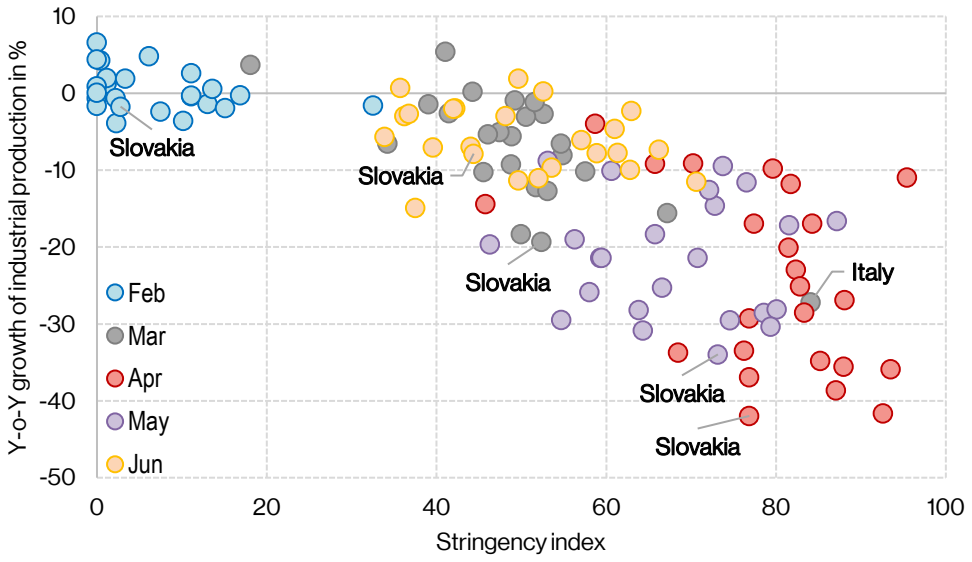


Source: Eurostat, ŠÚ SR, IFP

Quarantine measures are responsible for around one fourth of the fall in industrial production.

Measures to prevent the spreading of infections were also found to have an effect on manufacturing. Based on our estimates, over the period from March to May, quarantine measures contributed to the decline in industrial production by 8.5 percentage points which accounts for over one fourth of the total decline in production over the same period. Measures start to exhibit a significant impact on industrial activitiy when the stringency indicator exceeds 50 points, which is equivalent to the level of stringency measured in mid-June (based on the estimates in the final table of Box 1). The stringency of government measures, however, does not explain why Slovak manufacturing recorded a steeper decline in production than other countries, as the quarantine measures in Slovakia were relatively less stringent when compared to other countries in the EU.

Figure 12: More stringent quarantine measures limited manufacturing to a greater extent

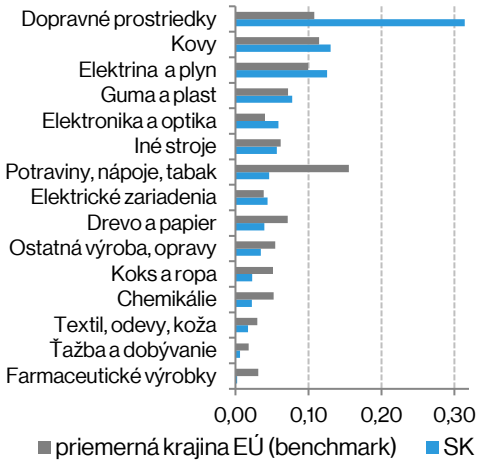


Source: ŠÚ SR, Eurostat, University of Oxford, IFP

The structure of Slovakia's manufacturing industry accounted for a third of the fall in production.

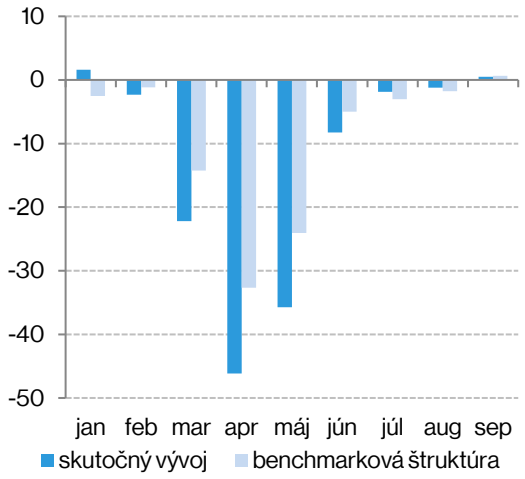
The structure of the Slovak manufacturing industry, relative to other EU countries, contributed to the overall fall of production by 11 percentage points between March and May, accounting for approximately one third of the overall fall in production. Acyclical

Figure 13: Structure of Slovakia's manufacturing sector relative to EU average



Sources: Eurostat, ŠÚ SR, IFP, own calculations

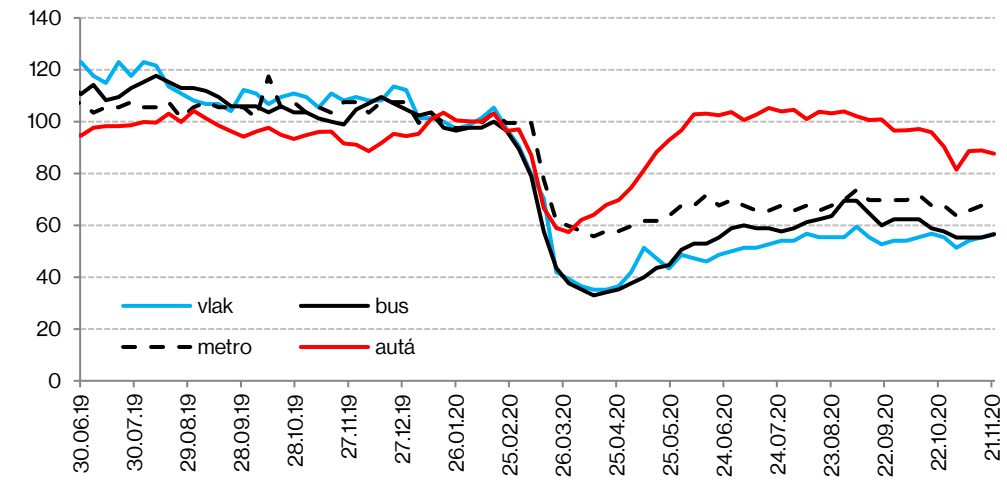
Figure 14: Real development in production relative to a hypothetical development of benchmark manufacturing (y-o-y growth in %)



Sources: Eurostat, ŠÚ SR, IFP, own calculations

industrial sectors, which had remained relatively stable during the pandemic, have a smaller share in domestic manufacturing. These include food production, which on average, represents 15 per cent of European manufacturing, compared to a 5 per cent share in Slovakia's manufacturing. The production of chemicals and pharmaceutical products, which fared well during the pandemic, also have a slightly lower share within the domestic manufacturing industry. Slovakia's manufacturing sectors are primarily influenced by developments in car production, which accounts for approximately 30 per cent of total industrial output. That is three times more than the European average. Since the automobile production has belonged to sectors which were the most affected by the pandemic globally, Slovak manufacturing was temporarily affected to a greater extent than in other countries. Following the swift recovery in industrial production after the first wave of the pandemic, the rebound in the auto sector helped erase lost production from the Spring months.

Figure 15: Global internet searches on Google (100 = January 2020)



Note: searches for cars represent average searches of major auto brands (Volkswagen, Kia, Porsche a Peugeot).
Source: Google, IFP

Future development in the demand for new cars remains uncertain.

In the future, industrial production in Slovakia will be mainly shaped by the global demand for cars and its response to the development of the pandemic and the evolution of government restrictions. A new wave of lockdowns could once again lead to a decrease in the mobility of the population. As witnessed during previous epidemics, the fear of contracting a disease may motivate a part of the population to switch from public to individual means of transportation, which could boost car production (Figure 15).[5] Given the uncertain economic outlook, however, this effect could manifest itself on the market for used vehicles. This is well illustrated by current developments in the United States, where used car turnover reached six year highs in August and September.[6]

[5] Google searches of the expressions "train", "bus" or "metro" are 40 per cent below their January 2020 levels. Internet searches have recovered only mildly since their dramatic fall in April. Searches related to car brands, however, have fully recovered over the summer months.

[6] „Used car boom is one of the hottest coronavirus markets for consumers", CNBC, accessed on 3 November.2020 at: https://www.cnbc.com/2020/10/15/used-car-boom-is-one-of-hottest-coronavirus-markets-for-consumers.html

BOX 1: Methodology

Conjunctural surveys in industry: limiting factors

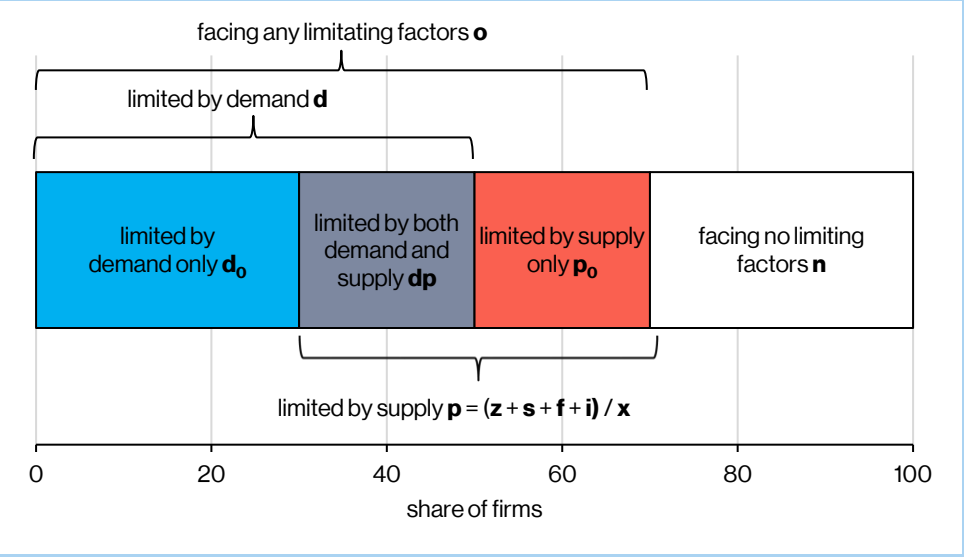
In order to estimate the share of demand and supply-related factors which limited production of Slovak manufacturers, we use the conjunctural surveys in industry by the Slovak Statistical Office (ŠÚ SR). Let the weighted share of respondents who report no limitations in production be **n** (the weighs of each respondents correspond to their share in industrial sales turnover). The survey allows respondents to choose multiple limiting factors from the following list:

- insufficient demand (let **d** represent the share of respondents who chose this option)
- insufficient labour force (**z**)
- insufficient machinery and/or commodities (**s**)
- financial constraints (**f**)
- other (**i**)

As insufficient demand has its own category among limiting factors in the survey, we assume that "other factors" include supply-side factors only.

Since firms can chose multiple limiting factors, the survey does not allow to directly deduce the share of firms which are only limited by demand-side factors, or supply-side factors, or both. It is possible and likely that firms which list demand-side factors in their questionnaire also face supply-side problems. Hence, let us define the following quantities:

- the share of firms facing any limitations to production $\mathbf{o} = 100 - \mathbf{n}$
- share of firms limited by *only supply-side factors* $\mathbf{p_o}$, while $\mathbf{p} = \mathbf{p_o} + \mathbf{dp}$, where **p** represents the share of firms limited by at least supply-side factor and **dp** represents the share of firms facing both demand and supply-side problems, and $\mathbf{p_o}$ equals $\mathbf{p_o} = \mathbf{o} - \mathbf{d}$
- share of firms limited by *only demand-side factors* $\mathbf{d_o}$, while $\mathbf{d} = \mathbf{d_o} + \mathbf{dp}$



The share of firms limited by at least one supply-side factor **p** does not necessarily equal the sum of **z**, **s**, **f** a **i**, as one firm can face various limiting factors. As a result, we calculate **p** as $\mathbf{p} = (\mathbf{z} + \mathbf{s} + \mathbf{f} + \mathbf{i}) / \mathbf{x}$, where **x** represents the average number of limiting factors chosen by a given firm. **x** is calculated as the share of the total number of selected limiting factors and the total number of firms that report any limitations $\mathbf{x} = (\mathbf{d} + \mathbf{z} + \mathbf{s} + \mathbf{f} + \mathbf{i}) / \mathbf{o}$.

Since **o**, **d**, $\mathbf{p_0}$ and **p** are known and calculating **dp** and $\mathbf{d_0}$ is trivial, $\mathbf{dp = p - p_0}$, $\mathbf{d_0 = d - dp}$.

The effect of government restrictions on industrial production

We use a panel regression to estimate the effect of pandemic restrictions. The year-on-year growth rate of industrial production is the dependent variable (*indprod)*. The stricktness of quarantine measures is measured by the Stringency Index created by the University of Oxford (*stringency*). To enable an easier interpretation of the quadratic terms, we divide the stringency index by 100. We run the regression on the individual components of the index as well (which are also divided by 100), in order to estimate which type of government restrictions has the most significant impact on industrial production.

Dependent variable: indprod

	Aggregate Stringency Index					Components of the index		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
intercept	0,02	0,01	0,06*	0,06	-0,10	0,04	0,06**	-0,00
	(0,01)	(0,01)	(0,03)	(0,09)	(0,09)	(0,11)	(0,03)	(0,02)
stringency	-0,26***	-0,11	-0,14	-0,14	0,18			
	(0,06)	(0,14)	(0,14)	(0,33)	(0,30)			
stringencyˆ2		-0,14	-0,15	-0,08	-0,26			
		(0,17)	(0,16)	(0,30)	(0,25)			
exportshare			-0,10					
			(0,06)					
carshare				-0,36***		-0,41***	-0,36***	
				(0,09)		(0,09)	(0,08)	
indprod(-1)				0,34***	-0,13	0,30***	0,34***	
				(0,10)	(0,11)	(0,10)	(0,09)	
stayhome						-2,70*	-3,29**	-2,96**
						(1,44)	(1,38)	(1,37)
gatherings						-0,91	-1,07	
						(0,67)	(0,69)	
events						-3,68**	-3,33**	-3,02*
						(1,45)	(1,29)	(1,32)
school						-0,22		
						(1,01)		
work						-0,69		
						(0,99)		
dom_travel						0,44		
						(1,11)		
int_travel						0,86		
						(0,97)		
transport						-2,09		
						(1,43)		
publicinfo						1,01		
						(5,99)		
fixed effects – months	yes	yes	yes	yes	yes	yes	yes	yes
fixed effects – countries	no	no	no	no	yes	no	no	yes
N	**120**	**120**	**120**	**92**	**96**	**92**	**92**	**120**
Rˆ2	**0,68**	**0,68**	**0,69**	**0,79**	**0,89**	**0,82**	**0,81**	**0,87**

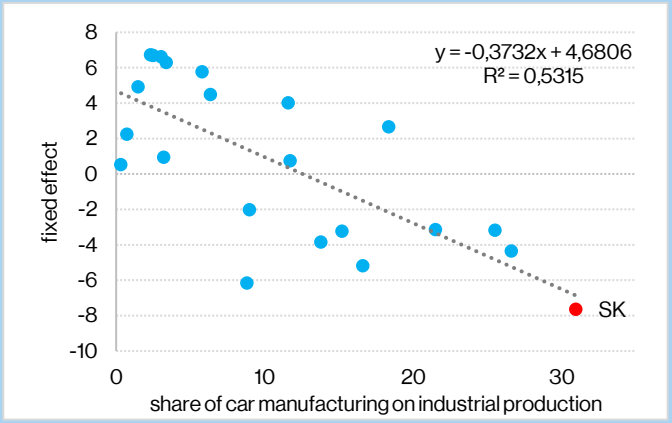
Note: standard errors of coefficientsare reported in the parantheses; * - statistical significance at the 10 % level, ** - statistical significance at the 5 % level, *** - statistical significance at the 1 % level.

Marginal effects of changes in the stringency index (*stringency*) on the year-on-year growth of production in the models with a quadratic term for various levels of stringency:

stringency	(2)	(3)	(4)	(5)
0	-0,11	-0,14	-0,14	0,19
	(0,14)	(0,14)	(0,33)	(0,30)
0,25	-0,18**	-0,21***	-0,19	-0,06
	(0,07)	(0,07)	(0,19)	(0,18)
0,5	-0,25***	-0,28***	-0,23***	-0,07
	(0,05)	(0,06)	(0,08)	(0,08)
0,75	-0,32**	-0,36***	-0,27**	-0,20*
	(0,12)	(0,12)	(0,14)	(0,11)
1	-0,39*	-0,43**	-0,31	-0,33
	(0,01)	(0,20)	(0,27)	(0,22)

Stricter quarantine measures start to have a statistically significant effect on industrial production when the stringency index increases considerably, while lower levels of the stringency index do not necessarily limit production. Among the components of the stringency index, restrictions on events (*events*), restrictions on movement (*stayhome*) and restrictions on gatherings (*gatherings*) have the statistically most significant impact on production. We use the share of exports on production (*exportshare*) to control for the openness of the economy and the share of car production on industrial production (*carshare*). The openness of the economy is at the border of statistical significance in Model 3 which is caused by Spain and Italy. These are big and relatively open economies and the decline in economic activity they experienced was mainly due to the severity of the pandemic during the first wave of infections. This skews the coefficient for openness upward. After adding a dummy variable for these two countries, the coefficient for openness becomes statistically significant (results are available from the author). Variables related to new COVID cases and new deaths in the given month are not statistically significant in most of the specifications and are hence not included in the reported regressions.

To account for the effect of unobserved factors which are specific for individual countries, we use fixed effects (in the models where fixed effects are used, we omit variables that do not vary over time, such as the share of car production on manufacturing). Each model contains fixed effects for individual months. Since after including country fixed effects we can no longer use the share of car production as a control variable, we estimate its impact by regressing the fixed effects on this variable. The difference in the share of car production on total manufacturing explains approximately half of the variation in fixed effects for individual countries.



We use a regression with year-on-year growth rates of individual manufacturing sectors as the dependent variable to calculate the contribution of each factors to the overall fall in industrial production. The stringency index, which measures the strictness of restrictions, is included in the regression as a categorical variable (10 categories). We

also include interactions to find the effect of individual variables throughout the given months. This allows us to calculate the effect of various factors on industrial activity in the period between March and May 2020.

Dependent variable: indprod (manufacturing sectors)

stringency		months*exportshare		months*carshare	
0-0,09	-	Jan	-0,01	Jan	-0,17***
			(0,02)		(0,06)
0,10-0,19	0,00	Feb	-0,01	Feb	-0,11*
	(0,01)		(0,02)		(0,06)
0,20-0,29	0,02	Mar	-0,06**	Mar	-0,21**
	(0,03)		(0,03)		(0,08)
0,30-0,39	-0,03**	Apr	-0,13***	Apr	-0,51***
	(0,03)		(0,04)		(0,11)
0,40-0,49	-0,02	May	-0,19***	May	-0,42***
	(0,02)		(0,03)		(0,09)
0,50-0,59	-0,05***	Jun	0,00	Jun	-0,21***
	(0,01)		(0,03)		(0,07)
0,60-0,69	-0,08***	Jul	-0,03	Jul	-0,19**
	(0,02)		(0,03)		(0,07)
0,70-0,79	-0,10***	constant	0,02		
	(0,02)		(0,01)		
0,80-0,89	-0,18***				
	(0,02)				
0,90-1,00	-0,34***				
	(0,05)				
N	**1937**				
R^2	**0,39**				

The contribution of the strictness of government measures in each month corresponds to the given coefficient. As in April, the stringency index was at 76.9 points in Slovakia, the contribution of restrictions to the change in production is estimated at -10.05 percentage points.

The contribution of openness to the decline in industrial activity in each sector is calculated as the product of the coefficient for the given month and *the difference in the openness of the given sector in Slovakia and the average openness of the same sector in EU countries*. We then weigh the contribution of each manufacturing sector by their share on overall industrial activity in Slovakia.

The contribution of the share of car production on overall production is quantified as the product of the coefficient for the given month and *the difference between the share of car production in Slovakia and the average share of car production in EU countries*.

Creating a benchmark index of industrial production

In order to determine the effect of the structure of Slovak manufacturing on the fall in industrial production during the first wave of the pandemic, we create a benchmark index of industrial production. Based on yearly national accounts data, we calculate the weights of each manufacturing sector on overall production for Slovakia and those EU countries for which data is

available.[7] We then weigh the sub-indices of Slovak industrial production firstly by their real share on overall Slovak manufacturing, and then by benchmark shares of each sector, **thus creating two synthetic indices of industrial production in Slovakia – one based on the true structure of Slovak manufacturing and a second one, based on the benchmark structure.**

$$IPP_t = \sum_{i=1}^{n} IPP_{i,t} * share_{\ i}$$

The difference in the development of the two indices allows us to quantify the contribution of the structure of the Slovak economy to the overall fall in industrial production.

Instead of the index calculated based on the true structure of the Slovak manufacturing industry, it would be possible to use the aggregate index of industrial production published by the Statistical Office (ŠÚ SR). This approach, however, would be less consistent. The development of the two indices is similar, but not identical. The weights used by the Statistical Office to calculate the aggregate index of production are similar, but not identical to the shares of each sector on overall manufacturing as reported in the national accounts. Part of the difference between the aggregate index calculated by ŠÚ SR and the benchmark industrial production index could thus be explained by the different methodology used when calculating the indices, and not the different structure of the manufacturing sector.

[7] The benchmark structure is based on data for EU countries, with the exception of Ireland, Lithuania, Luxembourg, Malta, and Sweden.